Original document

VENTED LOWER LINER FOR HEATING EXHAUST GAS IN SINGLE WAFER REACTOR

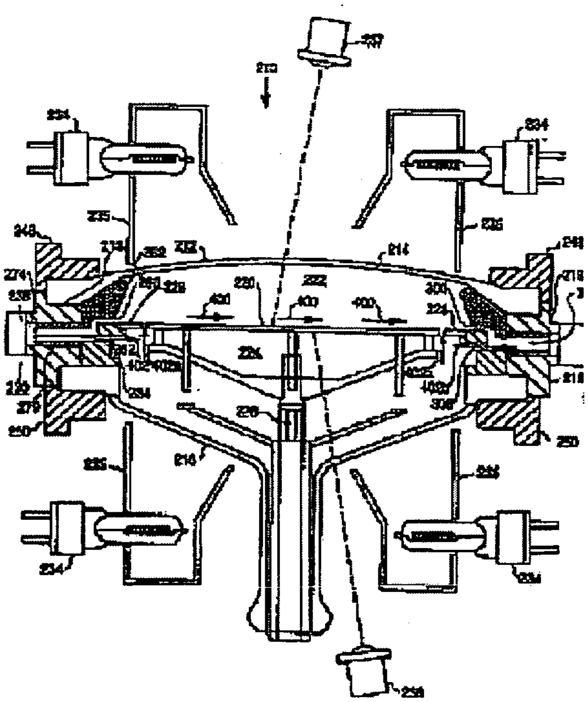
Patent number:	JP11045861	Also published a
Publication date:	1999-02-16	EP0870852
Inventor:	COMITA PAUL B; CARLSON DAVID K; RILEY NORMA B; FAN DORIA W; RANGANATHAN REKHA	US6153260
		EP0870852
Applicant:	APPLIED MATERIALS INC	
Classification:		
- international:	***C23C16/44; C23C16/48; C30B25/14; C30B31/16;*** **C23C16/44; C23C16/48; C30B25/14; C30B31/00;** (IPC1-7): H01L21/205; C23C16/44	
- european:		
Application number:	JP19980137330 19980410	
Priority number(s):	US19970835955 19970411	

View INPADOC patent family

Report a data error

Abstract of **JP11045861**

PROBLEM TO BE SOLVED: To provide a method and an apparatus which enable the reduction of formation of deposits in an exhaust passage and reduction of metal contamination from a lower part of a chamber. SOLUTION: A single wafer reactor having a vented lower liner for heating exhaust gas is provided. This apparatus includes a reaction chamber. A wafer support member which divides the chamber into upper and lower portions is positioned within the chamber. A gas outlet for exhausting gas from the chamber has a vent for exhausting a gas from the lower portion of the chamber and an opening of an exhaust passage 300 for exhausting the gas from the upper portion of the chamber. Heated inert purge gas is fed from the lower chamber portion 224 through the vent 306 so as to prevent the deposition gas from condensing inside the exhaust passage.



Description of corresponding document: **EP0870852**

The present invention relates to semiconductor processing equipment, more particularly, to a methoc apparatus for reducing particle contamination in a semiconductor processing apparatus.

One type of processing apparatus for semiconductor wafers is a single wafer processor in which one at a time is processed in a processing chamber. An example of a single wafer reactor is shown in Fig A susceptor 120 divides a chamber 112 into one portion which is below the susceptor (the lower por 124, and a second portion which is above the susceptor (the upper portion) 122. The susceptor 120 i: generally mounted on a shaft 126 which rotates the susceptor about its center to achieve a more unifi processing of the wafer. A flow of a processing gas, such as a deposition gas 115, is provided in the portion 122 of the chamber. The chamber generally has a gas inlet passage 178 at one side thereof, a gas exhaust passage 116 at an opposite side to achieve a flow of the processing gas across the wafer. susceptor 120 is heated in order to heat the wafer to a desired processing temperature. One method u heat the susceptor is by the use of lamps 134 provided around the chamber and directing their light i: chamber and onto the susceptor 120. In order to control the temperature to which the wafer is being the temperature of the susceptor is constantly measured. This is often achieved by means of an infrai temperature sensor 136 which detects the infra-red radiation emitted from the heated susceptor.

A problem with this type of processing apparatus is that some of the processing gas, which is often a mixture of gases for depositing a layer of a material on the surface of the wafer, tends to flow arounc edge of the susceptor and deposits a layer of the material on the back surface of the susceptor. Since deposited material is generally different from the material of the susceptor, the deposited layer has a: emissivity which is different from that of the emissivity of the susceptor. Thus, once the layer of the material is deposited on the back surface of the susceptor, the infrared temperature sensor detects a c caused by the change in the emissivity of the surface from which the infra-red radiation is emitted. T change indicates a change in temperature of the susceptor which actually does not exist.

One technique which has been used to prevent the problem of deposits on the back surface of the su: is to provide a flow of an inert gas 121, such as hydrogen, into the lower portion of the chamber at a pressure slightly greater than that of the deposition gas in the upper portion of the chamber. One app for achieving this is described in the application for U.S. Patent of Roger N. Anderson et al., Serial N 08/099/977, filed July 30, 1993, entitled "Gas Inlets For Wafer Processing Chamber". Since the iner the lower portion of the chamber is at a higher pressure, it will flow around the edge of the susceptoı the lower portion of the chamber and into the upper portion of the chamber. This flow of the inert ga prevents the flow of the deposition gas 115 into the lower portion of the chamber.Unfortunately, hov as the purge gas flows from the lower portion of the chamber to the upper portion of the chamber in to exit through the exhaust passage 116 located in the upper portion 122 of chamber 122, it carries n contaminants from the lower portion of the chamber into the upper portion, resulting in contaminatic wafers being processed.

Another problem associated with the processing apparatus of Figure 1 is that as deposition gas 115 e the chamber through exhaust passage 116, the deposition gas cools and condenses to form deposits 1 within the exhaust passage 116. Deposition gas cools because the apparatus of Figure 1 is a "cold wa reactor". That is, the sidewall of the deposition chamber is at a substantially lower temperature than susceptor 120 (and wafer) during processing because the sidewall is not directly irradiated by lamp 1 due to reflectors 135 and because cooling fluid is circulated through the sidewall. Since the sidewall the exhaust outlet passage are at a lower temperature, the deposition gas heated by susceptor 120 coc while in the passage and forms deposits 114 therein. These deposits 114 can find their way back intc chamber 112 and onto the wafer being processed.Deposits 114 can detrimentally affect film quality ; uniformity which can result in a substantial decrease in device yield.

Thus, what is desired is a method and apparatus which can reduce the formation of deposits in the e› passage and which can reduce metal contamination from the lower portion of the chamber.

In preferred embodiments, the present invention relates to a single wafer reactor having a vented lov liner for heating exhaust gas. The apparatus of the present invention preferably includes a reaction chamber. A wafer support member which divides the chamber into an upper and lower portion is preferably positioned within the chamber. An exhaust channel may be formed in the sidewall of the reaction chamber to exhaust gas from within the chamber. Deposition gas is preferably exhausted thı an exhaust passage located between the upper portion of the chamber and the exterior sidewall of the deposition chamber. A high flow rate of heated purge gas may be exhausted from the lower portion ‹ chamber through a vent located between the lower portion of the chamber and the exhaust passage.T high flow rate of heated purge gas into the exhaust passage prevents the exhausted deposition gas frc condensing in the exhaust passage and forming deposits therein.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an illustration of a cross-sectional view of a single wafer reactor.

Figure 2 is an illustration of a single wafer reactor of the present invention.

Figure 3 is an illustration of an expanded cross section view of the gas exhaust outlet of the single w reactor of the present invention.

Figure 4 is an illustration of an overhead view of the susceptor and preheat member of the single wa reactor of the present invention.

Figure 5a is an illustration of a frontal view of the vent and exhaust passage of an embodiment of the present invention.

Figure 5b is an illustration of a frontal view of the vent and exhaust passage of another embodiment present invention.

The present invention relates to a method and apparatus for preventing the condensation of depositic in the exhaust passage of a single wafer processing reactor. In the following description numerous sı details are set forth such as specific heating elements, gases, etc., in order to provide a thorough understanding of the invention. In other instances, well known reactor features and processes have n been explained in detail in order to not unnecessarily obscure the preferred featured present inventio

The present invention preferably relates to a single wafer reactor. A susceptor for holding a wafer to processed is positioned within a deposition chamber and divides the chamber into an upper portion a lower portion. Deposition gas which feeds into the upper portion of the chamber and across the wafe exhausted through an exhaust passage which extends from the upper portion of the chamber and out through a sidewall in the deposition chamber. An inert gas, such as H2, is fed into the lower portion chamber and is exhausted through a vent formed between the lower portion of the chamber and the ε passage. A high inert purge gas flow rate provides a large amount of heated gas into the exhaust pas: which prevents the deposition gases from condensing and forming deposits therein.Additionally, by exhausting the purge gas directly from the lower portion of the chamber, metal contamination from t lower portion of the chamber is reduced.

A semiconductor wafer processing apparatus 210 in accordance with a preferred embodiment of the present invention is shown on Figure 2. The processing apparatus 210 shown is a deposition reactor comprises a deposition chamber 212 having an upper dome 214, a lower dome 216 and a side wall 2

between the upper and lower domes 214 and 216. Cooling fluid (not shown) is circulated through si(218 in order to cool "o" rings used to attach domes 214 and 216 to sidewall 218. An upper liner 282 lower liner 284 are mounted against the inside surface of sidewall 218. The upper and lower domes : and 216 are made of a transparent material to allow heating light to pass there through into the cham 212.

Within the chamber 212 is a flat, circular susceptor 220 for supporting a wafer. The susceptor 220 e) transversely across the chamber 212 at the side wall 218 to divide the chamber 212 into an upper poı 222 above the susceptor 220 and a lower portion 224 below the susceptor 220. The susceptor 220 is mounted on a shaft 226 which extends perpendicularly downwardly from the center of the bottom oi susceptor 220. The shaft 226 is connected to a motor (not shown) which rotates shaft 226 and thereb rotates the susceptor 220. An annular preheat ring 228 is connected at its outer periphery to the insid periphery of lower liner 284 and extends around the susceptor 220. The pre-heat ring 228 is in the sa plane as the susceptor 228 with the inner edge of the pre-heat ring 228 separated by a gap 229 from ı outer edge of the susceptor 220.An inlet manifold 230 is positioned in the side of chamber 212 and i adapted to admit gas into the chamber 212. An outlet port 232 is positioned in the side of chamber 2 diagonally opposite the inlet manifold and is adapted to exhaust gases from the deposition chamber :

A plurality of high intensity lamps 234 are mounted around the chamber 212 and direct their light th the upper and lower domes 214 and 216 onto the susceptor 220 to heat the susceptor 220. The upper lower domes 214 and 216 are made of a material which is transparent to the light from the lamps 23‹ as clear quartz. The upper and lower domes 214 and 216 are generally made of quartz because quart: transparent to light of both visible and IR frequencies; it exhibits a relatively high structural strength is chemically stable in the process environment of the deposition chamber 212. Although lamps are ı preferred means for heating wafers in deposition chamber 220, other methods may be used such as resistance heaters and RF inductive heaters.An infrared temperature sensor 236 such as a pyrometer mounted below the lower dome 216 and faces the bottom surface of the susceptor 220 through the lc dome 216. The temperature sensor 236, is used to monitor the temperature of the susceptor 220 by receiving infra-red radiation emitted from the susceptor 220 when the susceptor 220 is heated. A temperature sensor 237 for measuring the temperature of a wafer may also be induded if desired.

An upper clamping ring 248 extends around the periphery of the outer surface of the upper domes 2: lower clamping ring 250 extends around the periphery of the outer surface of the lower dome 216. T upper and lower clamping rings are secured together so as to damp the upper and lower domes 214 ε 216 to the side wall 218.

Reactor 210 includes a deposition gas inlet manifold 230 for feeding deposition gas into chamber 21 deposition. Gas inlet manifold 230 includes a baffle 274, an insert plate 279 positioned within sidew 218, and a passage 260 formed between upper liner 282 and lower liner 284. Passage 260 is connect the upper portion 222 of chamber 212. Deposition gas such as a silicon source gas, a dopant source ք a carrier gas are fed from gas cap 238 through baffle 274, insert plate 279 and passage 260 and into ı upper portion 222 of chamber 212.

Reactor 210 also includes an independent inert gas inlet 262 for feeding an inert purge gas, such as ł limited to, Hydrogen (H2) or Nitrogen (N2), into the lower portion 224 of deposition chamber 212. ⁄ shown in Figure 2, inert purge gas inlet 262 can be integrated into gas inlet manifold 230, if desired, long as a physically separate and distinct passage 262 through baffel 274, insert plate 279, and lowei 284 is provided for the inert gas, so that the inert purge gas can be controlled and directed independe the deposition gas. Inert purge gas inlet 262 need not necessarily be integrated or positioned along w deposition gas inlet manifold 230, and can for example be positioned on reactor 210 at an angle of 9 from deposition gas inlet manifold 230.

A side cross-sectional view of an embodiment of the gas outlet 232 of the single wafer reactor of the present invention is shown in Figure 3. The gas outlet 232 includes an exhaust passage 300 which e› from the upper chamber portion 222 to the outside diameter of sidewall 218. Exhaust passage 300 in

an upper passage 302 formed between upper liner 282 and lower liner 284 and which extends betwe upper chamber portion 222 and the inner diameter of sidewall 218. Additionally, exhaust passage 30 includes an exhaust channel 304 formed within insert plate 278 positioned within sidewall 218. A va source, such as a pump (not shown) for creating low or reduced pressure in deposition chamber 212 coupled to exhaust channel 304 on the exterior of sidewall 218 by an outlet pipe 233.Thus, depositio fed into the upper chamber portion 222 is exhausted through the upper passage 302, through exhaust channel 304 and into outlet pipe 233.

The single wafer reactor shown in Figure 2 is a "cold wall" reactor. That is, sidewall 218 and upper a lower liners 282 and 284, respectively, are at a substantially lower temperature than susceptor 220 (a wafer placed thereon) during processing. For example, in a process to deposit an epitaxial silicon fil wafer, the susceptor and wafer are heated to a temperature of between 900-1200 DEG C while the si (and liners) are at a temperature of about 400-600 DEG C. The sidewall and liners are at a cooler temperature because they do not receive direct irradiation from lamps 234 due to reflectors 235, and because cooling fluid is circulated through sidewall 218.

Gas outlet 232 also includes a vent 306 which extends from the lower chamber portion 224 through liner 284 to exhaust passage 300. Vent 306 preferably intersects the upper passage 302 of exhaust pa 300 as shown in Figure 3. Inert purge gas is exhausted from the lower chamber portion 224 through 306, through a portion of upper chamber passage 302, through exhaust channel 304, and into outlet p 232. Vent 306 allows for the direct exhausting of purge gas from the lower chamber portion to exhau passage 300.

According to one embodiment of the present invention, deposition gas or gases 400 are fed into the u chamber portion 222 from gas inlet manifold 230. A deposition gas, according to the present inventi defined as gas or gas mixture which acts to deposit a film on a wafer or a substrate placed in chambe In the preferred method of the present invention deposition gas is used to deposit a silicon epitaxial l on a wafer placed on susceptor 220. Deposition gas 400 generally includes a silicon source, such as l limited to, monosilane, trichloralsilane, dichloralsilane, and tetrachlorolsilane, and a dopant gas sour such as but not limited to phosphene, diborane and arsine. A carrier gas, such as H2, is generally inc in the deposition gas stream.For an approximately 5 liter deposition chamber, a deposition gas strear between 35-75 SLM (including carrier gas) is typically fed into the upper chamber portion 222 to de layer of silicon on a wafer. The flow of deposition gas 400 is essentially a laminar flow from inlet pa 260, across preheat ring 228, across susceptor 220 (and wafer), across the opposite side of preheat ri 228, and out exhaust passage 300. The deposition gas is heated to a deposition or process temperatu preheat ring 228 susceptor 220, and the wafer being processed. In a process to deposit an epitaxial si layer on a wafer, the susceptor and preheat ring are heated to a temperature of between 800-1200 DE

Additionally, while deposition gas is fed into the upper chamber portion, an inert purge gas or gases are fed independently into the lower chamber portion 224. An inert purge gas is defined as a gas whi substantially unreactive at process temperatures with chamber features and wafers placed in depositi chamber 212. The inert purge gas is heated by preheat ring 228 and susceptor 220 to essentially the s temperature as the deposition gas while in chamber 212. Inert purge gas 402 is fed into the lower cha portion 224 at a rate which develops a positive pressure within lower chamber portion 224 with resp the deposition gas pressure in the upper chamber portion 222. Film Deposition gas 400 is therefore prevented from seeping down through gap 229 and into the lower chamber portion 224, and depositi the back side of susceptor 220.

Additionally, inert purge gas 402 is fed into the lower chamber portion 224 at a rate which provides sufficient flow of inert purge gas 402b through vent 306 and into exhaust passage 300 to prevent deposition gas from condensing in exhaust channel 304 of exhaust passage 300 and forming deposit therein. That is, a sufficient amount of heated purge gas is fed into exhaust channel 304 to heat exha channel 304, and thereby prevent the cooling of deposition gas 400 in exhaust channel 304 and the resulting formation of deposits therein. It is to be appreciated that without the high flow rate of heate purge gas 402b into the exhaust channel 304, the exhaust channel 304 would be substantially cooler

susceptor 220 due to the water cooling of sidewall 218, and deposits would form therein.Thus, accoı to the present invention, a high flow rate 402b, preferably between 2-24 SLM, of inert purge gas is f the lower portion 224 of chamber 212, in order to prevent deposition gas from seeping down througl 229 and to prevent deposition gas from condensing in the exhaust channel 304.

Figures 5a and 5b show frontal cross-sectional views of two of many possible configurations for ven For example, as shown in Figure 5a, vent 306 can be located directly beneath upper passage 302 and consist of a single cross-sectional opening formed in the inner curved surface of lower liner 284. Th cross-sectional opening into chamber 222 is preferably at least as long as the diameter of the process area on susceptor 220. In another embodiment, as shown in Figure 5b, vent 306 can consist of a plur of discreet holes or passages 502 formed in the inner curved surface of lower liner 284 and which ar coupled to exhaust passage 300. The shape of vent 306 should be such that it provides little affect or laminar flow of deposition gas 400 in the upper portion 222 of chamber 212.

The relative flow rates 402a and 402b through gap 229 and vent 306, respectively, are governed by t ratio of the cross-sectional area of gap 229 and the cross-sectional area of vent 306. In the preferred embodiment of the present invention as shown in Figure 4, where the preheat ring and susceptor are coplanar, the cross-sectional area of gap 229 is the area defined by the enclosed area of preheat ring minus the area of susceptor 220 (i.e., pi R2_P- pi R2_S). If susceptor 220 and preheat ring 228 are interleavened then the relevant cross-sectional area is the smallest surface area which exists between preheat ring 228 and susceptor 220. The cross-sectional area of vent 306 is defined as the total surfa of vent 306 which opens into lower chamber portion 224.In the case of a plurality of discreet passag shown in figure 5b, the relevant cross-section area is the sum of the areas of each opening 502.

According to the present invention, the cross-sectional area of vent 229 is maximized so as to exhau much of the purge gas flow as possible through vent 306. In this way a sufficient amount of heated i purge gas is provided to prevent deposition gas from condensing in the exhaust passage. The cross-sectional area of vent 306 is dictated by two requirements. First, the cross-sectional area of vent 306 be so large so as to affect the mechanical strength and integrity of lower liner 284. Additionally, the of cross-sectional area of gap 229 and vent 306 must be balanced so that the inert purge gas flow 40 through gap 229 is sufficient to prevent the diffusion of deposition gases from the upper chamber po 222 into the lower chamber portion 224.A gap 229 to vent 306 cross-sectional area ratio of approxin 3:1 has been found to provide good results for a deposition gas flow of between 45-70 slm and a pur flow of greater than 12 slm in a five liter chamber.

An apparatus and method for preventing condensation of deposition gas in an exhaust passage of a deposition apparatus has been described. It is to be appreciated and understood that the specific embodiments of the invention described herein are merely illustrative of the general principles of the invention. Various modifications may be made consistent with the principles set forth. For example, although the present invention has been described with respect to a single substrate reactor for depos silicon film on a semiconductor wafer, the present invention is equally applicable for use in other machinery such as multi-wafer chambers, and for other substrates, such as substrates for flat panel displays, and for other films such as metals. As such, the scope of the present invention is to be mea by the appended claims which follow.

Claims of corresponding document: **EP0870852**

1. A method of depositing a form in a semiconductor reactor, said method comprising to steps of:

flowing a deposition gas into a reaction chamber;
exhausting said deposition gas through an exhaust passage; and

flowing a heated inert purge gas into said exhaust passage at a rate so as to prevent said deposition g from condensing in said exhaust passage.

2.A method of depositing a film on a wafer in a single wafer reactor, said method comprising the ste

placing a wafer on a susceptor which divides a deposition chamber having a sidewall into an upper chamber portion and a lower chamber portion;
flowing a deposition gas into said upper chamber portion, across said wafer, and out through an exh passage extending from said upper chamber through said sidewall;
flowing a purge gas into said lower chamber portion and out through a lower passage extending fron lower chamber portion to said exhaust passage;
heating said purge gas while in said chamber; and
flowing said purge gas through said lower passage at a rate that prevents said deposition gas from condensing in said exhaust passage.

3.A method of depositing a film on a wafer in a single substrate reactor, said method comprising the of;

placing a wafer on a susceptor positioned within a deposition chamber having a sidewall, said susce dividing said deposition chamber into an upper portion which is above said wafer, and a lower portic which is below said wafer;
flowing a deposition gas into said upper portion of said deposition chamber;
exhausting said deposition gas through an exhaust passage extending from said upper portion of saic deposition chamber through said sidewall;
flowing a purge gas into said lower portion of said deposition chamber wherein said flow of purge g substantially prevents said deposition gas from flowing into said lower portion of said deposition ch through a gap between said susceptor plate and a preheat member which surrounds said susceptor pl and
exhausting said purge gas through a lower passage extending from said lower chamber to said exhau passage wherein said heated purge gas prevents said deposition gas in said exhaust passage from condensing.

4. A deposition apparatus for depositing a layer of material on a wafer, said apparatus comprising:

a deposition chamber having a side wall;
a susceptor plate in a first plane within said deposition chamber, said susceptor plate extending acro deposition chamber to divide said deposition chamber into an upper portion which is above the top s of the susceptor plate on which a wafer is supported, and a lower portion which is below the back su of the susceptor plate;
a preheat ring in said first plane and surrounding said susceptor plate, said preheat ring separated fro susceptor plate by a gap having a first cross-sectional area;
a vent extending from said lower portion of said deposition chamber liner to said exhaust passage, s vent having a second cross-sectional area; and
an exhaust passage extending from said upper portion of said deposition chamber through said sidev wherein said second cross-sectional area and said first cross-sectional have a relative relationship wl allows heated purge gas in the lower chamber to prevent deposition gas in the upper portion of the c from flowing through said gap and to provide a sufficient amount of heated gas into said exhaust pa so that deposition gas in said exhaust passage does not condense therein.

5. The apparatus of claim 4 wherein said vent comprises a single elongated opening position directly the opening of said exhaust passage.

6. The apparatus of claim 4 wherein said vent comprises a plurality of discreet openings.

7. The apparatus of claim 4 wherein said first cross-sectional area and said second cross-sectional ar have a ratio of approximately 3:1.

8. The method of claim 4 wherein said purge gas is heated by a plurality of lamps.

9.The apparatus of claim 4 further comprising an upper dome, a lower dome, and wherein said side situated between said upper dome and said lower dome.

10. The deposition apparatus of claim 4 further comprising:
a gas inlet manifold in the wall of the chamber, said gas inlet manifold having at least one passage o to direct a gas into said lower portion of said deposition chamber and at least one passage opening tc gas into said upper portion of said deposition chamber.

11. The deposition apparatus of claim 8 further comprising:
a gas inlet manifold in the wall of the chamber, said gas inlet manifold having at least one passage o to direct a gas into said lower portion of said deposition chamber and at least one passage opening tc gas into said upper portion of said deposition chamber.

12.A deposition apparatus for depositing a layer of material on a wafer, said apparatus comprising:

a deposition chamber having a side wall;
a susceptor plate in a first plane within said deposition chamber, said susceptor plate extending acro deposition chamber to divide said deposition chamber into an upper portion which is above the top s of the susceptor plate on which a wafer is supported, and a lower portion which is below the back su of the susceptor plate;
a preheat ring in said first plane and surrounding said susceptor plate, said preheat ring separated fro susceptor plate by a gap having a first cross-sectional area;
an upper liner seated against the inner surface of said side wall in said upper portion of said depositi chamber;
a lower liner seated against the inner surface of said side wall in said lower portion of said depositio chamber;
a vent extending from said lower portion of said deposition chamber through said lower liner to said exhaust passage, said vent having a second cross-sectional area; and
an exhaust passage located between said upper liner and said lower liner and extending from said up portion of said deposition chamber through said sidewall;
wherein said second cross-sectional area and said first cross-sectional have a relative relationship wh allows heated purge gas in the lower chamber to prevent deposition gas in the upper portion of the c from flowing through said gap and to provide a sufficient amount of heated gas into said exhaust pas so that deposition gas in said exhaust passage does not condense therein.

【外国語明細書】

1. Title of Invention

VENTED LOWER LINER FOR HEATING EXHAUST GAS IN
A SINGLE SUBSTRATE REACTOR

2. Claims

IN THE CLAIMS

We claim:

1. A method of depositing a form in a semiconductor reactor, said method comprising to steps of:

flowing a deposition gas into a reaction chamber;

exhausting said deposition gas through an exhaust passage; and

flowing a heated inert purge gas into said exhaust passage at a rate so as to prevent said deposition gas from condensing in said exhaust passage.

2. A method of depositing a film on a wafer in a single wafer reactor, said method comprising the steps of;

placing a wafer on a susceptor which divides a deposition chamber having a sidewall into an upper chamber portion and a lower chamber portion;

flowing a deposition gas into said upper chamber portion, across said wafer, and out through an exhaust passage extending from said upper chamber through said sidewall;

flowing a purge gas into said lower chamber portion and out through a lower passage extending from said lower chamber portion to said exhaust passage;

heating said purge gas while in said chamber; and

flowing said purge gas through said lower passage at a rate that prevents said deposition gas from condensing in said exhaust passage.

3. A method of depositing a film on a wafer in a single substrate reactor, said method comprising the steps of;

placing a wafer on a susceptor positioned within a deposition chamber having a sidewall, said susceptor dividing said deposition chamber into an upper portion which is above said wafer, and a lower portion which is below said wafer;

flowing a deposition gas into said upper portion of said deposition chamber;

exhausting said deposition gas through an exhaust passage extending from said upper portion of said deposition chamber through said sidewall;

flowing a purge gas into said lower portion of said deposition chamber wherein said flow of purge gas substantially prevents said deposition gas from flowing into said lower portion of said deposition chamber through a gap between said susceptor plate and a preheat member which surrounds said susceptor plate; and

exhausting said purge gas through a lower passage extending from said lower chamber to said exhaust passage wherein said heated purge gas prevents said deposition gas in said exhaust passage from condensing.

4. A deposition apparatus for depositing a layer of material on a wafer, said apparatus comprising:

a deposition chamber having a side wall;

a susceptor plate in a first plane within said deposition chamber, said susceptor plate extending across said deposition chamber to divide said deposition chamber into an upper portion which is above the top surface of

the susceptor plate on which a wafer is supported, and a lower portion which is below the back surface of the susceptor plate;

a preheat ring in said first plane and surrounding said susceptor plate, said preheat ring separated from said susceptor plate by a gap having a first cross-sectional area;

a vent extending from said lower portion of said deposition chamber liner to said exhaust passage, said vent having a second cross-sectional area; and

an exhaust passage extending from said upper portion of said deposition chamber through said sidewall;

wherein said second cross-sectional area and said first cross-sectional have a relative relationship which allows heated purge gas in the lower chamber to prevent deposition gas in the upper portion of the chamber from flowing through said gap and to provide a sufficient amount of heated gas into said exhaust passage so that deposition gas in said exhaust passage does not condense therein.

5. The apparatus of claim 4 wherein said vent comprises a single elongated opening position directly below the opening of said exhaust passage.

6. The apparatus of claim 4 wherein said vent comprises a plurality of discreet openings.

7. The apparatus of claim 4 wherein said first cross-sectional area and said second cross-sectional area have a ratio of approximately 3:1.

8. The method of claim 4 wherein said purge gas is heated by a plurality of lamps.

9. The apparatus of claim 4 further comprising an upper dome, a lower dome, and wherein said side wall is situated between said upper dome and said lower dome.

10. The deposition apparatus of claim 4 further comprising:

a gas inlet manifold in the wall of the chamber, said gas inlet manifold having at least one passage opening to direct a gas into said lower portion of said deposition chamber and at least one passage opening to direct gas into said upper portion of said deposition chamber.

11. The deposition apparatus of claim 8 further comprising:

a gas inlet manifold in the wall of the chamber, said gas inlet manifold having at least one passage opening to direct a gas into said lower portion of said deposition chamber and at least one passage opening to direct gas into said upper portion of said deposition chamber.

12. A deposition apparatus for depositing a layer of material on a wafer, said apparatus comprising:

a deposition chamber having a side wall;

a susceptor plate in a first plane within said deposition chamber, said susceptor plate extending across said deposition chamber to divide said deposition chamber into an upper portion which is above the top surface of the susceptor plate on which a wafer is supported, and a lower portion which is below the back surface of the susceptor plate;

a preheat ring in said first plane and surrounding said susceptor plate, said preheat ring separated from said susceptor plate by a gap having a first cross-sectional area;

an upper liner seated against the inner surface of said side wall in said upper portion of said deposition chamber;

a lower liner seated against the inner surface of said side wall in said lower portion of said deposition chamber;

a vent extending from said lower portion of said deposition chamber through said lower liner to said exhaust passage, said vent having a second cross-sectional area; and

an exhaust passage located between said upper liner and said lower liner and extending from said upper portion of said deposition chamber through said sidewall;

wherein said second cross-sectional area and said first cross-sectional have a relative relationship which allows heated purge gas in the lower chamber to prevent deposition gas in the upper portion of the chamber from flowing through said gap and to provide a sufficient amount of heated gas into said exhaust passage so that deposition gas in said exhaust passage does not condense therein.

3. Detailed Description of Invention

BACKGROUND OF THE INVENTION

1) FIELD OF THE INVENTION

The present invention relates to semiconductor processing equipment, more particularly, to a method and apparatus for reducing particle contamination in a semiconductor processing apparatus.

2) DISCUSSION OF RELATED ART

One type of processing apparatus for semiconductor wafers is a single wafer processor in which one wafer at a time is processed in a processing chamber. An example of a single wafer reactor is shown in Figure 1. A susceptor 120 divides a chamber 112 into one portion which is below the susceptor (the lower portion) 124, and a second portion which is above the susceptor (the upper portion) 122. The susceptor 120 is generally mounted on a shaft 126 which rotates the susceptor about its center to achieve a more uniform processing of the wafer. A flow of a processing gas, such as a deposition gas 115, is provided in the upper portion 122 of the chamber. The chamber generally has a gas inlet passage 178 at one side thereof, and a gas exhaust passage 116 at an opposite side to achieve a flow of the processing gas across the wafer. The susceptor 120 is heated in order to heat the wafer to a

desired processing temperature. One method used to heat the susceptor is by the use of lamps 134 provided around the chamber and directing their light into the chamber and onto the susceptor 120. In order to control the temperature to which the wafer is being heated, the temperature of the susceptor is constantly measured. This is often achieved by means of an infrared temperature sensor 136 which detects the infra-red radiation emitted from the heated susceptor.

A problem with this type of processing apparatus is that some of the processing gas, which is often a gas or mixture of gases for depositing a layer of a material on the surface of the wafer, tends to flow around the edge of the susceptor and deposits a layer of the material on the back surface of the susceptor. Since the deposited material is generally different from the material of the susceptor, the deposited layer has an emissivity which is different from that of the emissivity of the susceptor. Thus, once the layer of the material is deposited on the back surface of the susceptor, the infrared temperature sensor detects a change caused by the change in the emissivity of the surface from which the infra-red radiation is emitted. This change indicates a change in temperature of the susceptor which actually does not exist.

One technique which has been used to prevent the problem of deposits on the back surface of the susceptor is to provide a flow of an inert gas 121, such as hydrogen, into the lower portion of the chamber at a pressure slightly greater than that of the deposition gas in the upper portion of the chamber. One apparatus for achieving this is described in the application for U.S. Patent of Roger N. Anderson et al., Serial No. 08/099/977, filed July 30, 1993, entitled "Gas Inlets For Wafer Processing Chamber". Since the inert gas in the lower portion of the chamber is at a higher pressure, it will flow around the edge of

the susceptor from the lower portion of the chamber and into the upper portion of the chamber. This flow of the inert gas prevents the flow of the deposition gas 115 into the lower portion of the chamber. Unfortunately, however, as the purge gas flows from the lower portion of the chamber to the upper portion of the chamber in order to exit through the exhaust passage 116 located in the upper portion 122 of chamber 122, it carries metal contaminants from the lower portion of the chamber into the upper portion, resulting in contamination of wafers being processed.

Another problem associated with the processing apparatus of Figure 1 is that as deposition gas 115 exits the chamber through exhaust passage 116, the deposition gas cools and condenses to form deposits 114 within the exhaust passage 116. Deposition gas cools because the apparatus of Figure 1 is a "cold wall reactor". That is, the sidewall of the deposition chamber is at a substantially lower temperature than is susceptor 120 (and wafer) during processing because the sidewall is not directly irradiated by lamp 134 due to reflectors 135 and because cooling fluid is circulated through the sidewall. Since the sidewall and the exhaust outlet passage are at a lower temperature, the deposition gas heated by susceptor 120 cools while in the passage and forms deposits 114 therein. These deposits 114 can find their way back into chamber 112 and onto the wafer being processed. Deposits 114 can detrimentally affect film quality and uniformity which can result in a substantial decrease in device yield.

Thus, what is desired is a method and apparatus which can reduce the formation of deposits in the exhaust passage and which can reduce metal contamination from the lower portion of the chamber.

SUMMARY OF THE INVENTION

The present invention is a single wafer reactor having a vented lower liner for heating exhaust gas. The apparatus of the present invention includes a reaction chamber. A wafer support member which divides the chamber into an upper and lower portion is positioned within the chamber. An exhaust channel is formed in the sidewall of the reaction chamber to exhaust gas from within the chamber. Deposition gas is exhausted through an exhaust passage located between the upper portion of the chamber and the exterior sidewall of the deposition chamber. A high flow rate of heated purge gas is exhausted from the lower portion of the chamber through a vent located between the lower portion of the chamber and the exhaust passage. The high flow rate of heated purge gas into the exhaust passage prevents the exhausted deposition gas from condensing in the exhaust passage and forming deposits therein.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The present invention describes a method and apparatus for preventing the condensation of deposition gas in the exhaust passage of a single wafer processing reactor. In the following description numerous specific details are set forth such as specific heating elements, gases, etc., in order to provide a thorough understanding of the invention. In other instances, well known reactor features and processes have not been explained in detail in order to not unnecessarily obscure the present invention.

The present invention is a single wafer reactor. A susceptor for holding a wafer to be processed is positioned within a deposition chamber and divides the chamber into an upper portion and a lower portion. Deposition gas which feeds into the upper portion of the chamber and across the wafer is exhausted through an exhaust passage which extends from the upper portion of the chamber and out through a sidewall in the deposition chamber. An inert gas, such as H_2, is fed into the lower portion of the chamber and is exhausted through a vent formed between the lower portion of the chamber and the exhaust passage. A high inert purge gas flow rate provides a large amount of heated gas into the exhaust passage which prevents the deposition gases from condensing and forming deposits therein. Additionally, by exhausting the purge gas directly from the lower portion of the chamber, metal contamination from the lower portion of the chamber is reduced.

A semiconductor wafer processing apparatus 210 in accordance with the present invention is shown on Figure 2. The processing apparatus 210 shown is a deposition reactor and comprises a deposition chamber 212 having an upper dome 214, a lower dome 216 and a side wall 218 between the upper

and lower domes 214 and 216. Cooling fluid (not shown) is circulated through sidewall 218 in order to cool "o" rings used to attach domes 214 and 216 to sidewall 218. An upper liner 282 and a lower liner 284 are mounted against the inside surface of sidewall 218. The upper and lower domes 214 and 216 are made of a transparent material to allow heating light to pass there through into the chamber 212.

Within the chamber 212 is a flat, circular susceptor 220 for supporting a wafer. The susceptor 220 extends transversely across the chamber 212 at the side wall 218 to divide the chamber 212 into an upper portion 222 above the susceptor 220 and a lower portion 224 below the susceptor 220. The susceptor 220 is mounted on a shaft 226 which extends perpendicularly downwardly from the center of the bottom of the susceptor 220. The shaft 226 is connected to a motor (not shown) which rotates shaft 226 and thereby rotates the susceptor 220. An annular preheat ring 228 is connected at its outer periphery to the inside periphery of lower liner 284 and extends around the susceptor 220. The pre-heat ring 228 is in the same plane as the susceptor 228 with the inner edge of the pre-heat ring 228 separated by a gap 229 from the outer edge of the susceptor 220. An inlet manifold 230 is positioned in the side of chamber 212 and is adapted to admit gas into the chamber 212. An outlet port 232 is positioned in the side of chamber 212 diagonally opposite the inlet manifold and is adapted to exhaust gases from the deposition chamber 212.

A plurality of high intensity lamps 234 are mounted around the chamber 212 and direct their light through the upper and lower domes 214 and 216 onto the susceptor 220 to heat the susceptor 220. The upper and lower domes 214 and 216 are made of a material which is transparent to the light from the lamps 234, such as clear quartz. The upper and lower domes 214 and 216 are generally made of quartz because quartz is transparent to light of both

visible and IR frequencies; it exhibits a relatively high structural strength; and it is chemically stable in the process environment of the deposition chamber 212. Although lamps are the preferred means for heating wafers in deposition chamber 220; other methods may be used such as resistance heaters and RF inductive heaters. An infrared temperature sensor 236 such as a pyrometer is mounted below the lower dome 216 and faces the bottom surface of the susceptor 220 through the lower dome 216. The temperature sensor 236, is used to monitor the temperature of the susceptor 220 by receiving infra-red radiation emitted from the susceptor 220 when the susceptor 220 is heated. A temperature sensor 237 for measuring the temperature of a wafer may also be included if desired.

An upper clamping ring 248 extends around the periphery of the outer surface of the upper domes 214. A lower clamping ring 250 extends around the periphery of the outer surface of the lower dome 216. The upper and lower clamping rings are secured together so as to clamp the upper and lower domes 214 and 216 to the side wall 218.

Reactor 210 includes a deposition gas inlet manifold 230 for feeding deposition gas into chamber 212 deposition. Gas inlet manifold 230 includes a baffle 274, an insert plate 279 positioned within sidewall 218, and a passage 260 formed between upper liner 282 and lower liner 284. Passage 260 is connected to the upper portion 222 of chamber 212. Deposition gas such as a silicon source gas, a dopant source gas and a carrier gas are fed from gas cap 238 through baffle 274, insert plate 279 and passage 260 and into the upper portion 222 of chamber 212.

Reactor 210 also includes an independent inert gas inlet 262 for feeding an inert purge gas, such as but not limited to, Hydrogen (H_2) or Nitrogen (N_2), into the lower portion 224 of deposition chamber 212. As shown in

Figure 2, inert purge gas inlet 262 can be integrated into gas inlet manifold 230, if desired, as long as a physically separate and distinct passage 262 through baffel 274, insert plate 279, and lower liner 284 is provided for the inert gas, so that the inert purge gas can be controlled and directed independent of the deposition gas. Inert purge gas inlet 262 need not necessarily be integrated or positioned along with deposition gas inlet manifold 230, and can for example be positioned on reactor 210 at an angle of 90° from deposition gas inlet manifold 230.

A side cross-sectional view of an embodiment of the gas outlet 232 of the single wafer reactor of the present invention is shown in Figure 3. The gas outlet 232 includes an exhaust passage 300 which extends from the upper chamber portion 222 to the outside diameter of sidewall 218. Exhaust passage 300 includes an upper passage 302 formed between upper liner 282 and lower liner 284 and which extends between the upper chamber portion 222 and the inner diameter of sidewall 218. Additionally, exhaust passage 300 includes an exhaust channel 304 formed within insert plate 278 positioned within sidewall 218. A vacuum source, such as a pump (not shown) for creating low or reduced pressure in deposition chamber 212 is coupled to exhaust channel 304 on the exterior of sidewall 218 by an outlet pipe 233. Thus, deposition gas fed into the upper chamber portion 222 is exhausted through the upper passage 302, through exhaust channel 304 and into outlet pipe 233.

The single wafer reactor shown in Figure 2 is a "cold wall" reactor. That is, sidewall 218 and upper and lower liners 282 and 284, respectively, are at a substantially lower temperature than susceptor 220 (and a wafer placed thereon) during processing. For example, in a process to deposit an epitaxial silicon film on a wafer, the susceptor and wafer are heated to a temperature of

between 900-1200°C while the sidewall (and liners) are at a temperature of about 400-600°C. The sidewall and liners are at a cooler temperature because they do not receive direct irradiation from lamps 234 due to reflectors 235, and because cooling fluid is circulated through sidewall 218.

Gas outlet 232 also includes a vent 306 which extends from the lower chamber portion 224 through lower liner 284 to exhaust passage 300. Vent 306 preferably intersects the upper passage 302 of exhaust passage 300 as shown in Figure 3. Inert purge gas is exhausted from the lower chamber portion 224 through vent 306, through a portion of upper chamber passage 302, through exhaust channel 304, and into outlet pipe 232. Vent 306 allows for the direct exhausting of purge gas from the lower chamber portion to exhaust passage 300.

According to the present invention, deposition gas or gases 400 are fed into the upper chamber portion 222 from gas inlet manifold 230. A deposition gas, according to the present invention, is defined as gas or gas mixture which acts to deposit a film on a wafer or a substrate placed in chamber 212. In the preferred method of the present invention deposition gas is used to deposit a silicon epitaxial layer on a wafer placed on susceptor 220. Deposition gas 400 generally includes a silicon source, such as but not limited to, monosilane, trichloralsilane, dichloralsilane, and tetrachlorolsilane, and a dopant gas source, such as but not limited to phosphene, diborane and arsine. A carrier gas, such as H_2, is generally included in the deposition gas stream. For an approximately 5 liter deposition chamber, a deposition gas stream between 35-75 SLM (including carrier gas) is typically fed into the upper chamber portion 222 to deposit a layer of silicon on a wafer. The flow of deposition gas 400 is essentially a laminar flow from inlet passage 260, across preheat ring 228, across susceptor

220 (and wafer), across the opposite side of preheat ring 228, and out exhaust passage 300. The deposition gas is heated to a deposition or process temperature by preheat ring 228 susceptor 220, and the wafer being processed. In a process to deposit an epitaxial silicon layer on a wafer, the susceptor and preheat ring are heated to a temperature of between 800-1200°C.

Additionally, while deposition gas is fed into the upper chamber portion, an inert purge gas or gases 402 are fed independently into the lower chamber portion 224. An inert purge gas is defined as a gas which is substantially unreactive at process temperatures with chamber features and wafers placed in deposition chamber 212. The inert purge gas is heated by preheat ring 228 and susceptor 220 to essentially the same temperature as the deposition gas while in chamber 212. Inert purge gas 402 is fed into the lower chamber portion 224 at a rate which develops a positive pressure within lower chamber portion 224 with respect to the deposition gas pressure in the upper chamber portion 222. Film Deposition gas 400 is therefore prevented from seeping down through gap 229 and into the lower chamber portion 224, and depositing on the back side of susceptor 220.

Additionally, inert purge gas 402 is fed into the lower chamber portion 224 at a rate which provides a sufficient flow of inert purge gas 402b through vent 306 and into exhaust passage 300 to prevent deposition gas from condensing in exhaust channel 304 of exhaust passage 300 and forming deposits therein. That is, a sufficient amount of heated purge gas is fed into exhaust channel 304 to heat exhaust channel 304, and thereby prevent the cooling of deposition gas 400 in exhaust channel 304 and the resulting formation of deposits therein. It is to be appreciated that without the high flow rate of heated purge gas 402b into the exhaust channel 304, the exhaust channel 304 would be substantially cooler than susceptor 220 due to the water

cooling of sidewall 218, and deposits would form therein. Thus, according to the present invention, a high flow rate 402b, preferably between 2-24 SLM, of inert purge gas is fed into the lower portion 224 of chamber 212, in order to prevent deposition gas from seeping down through gap 229 and to prevent deposition gas from condensing in the exhaust channel 304.

Figures 5a and 5b show frontal cross-sectional views of two of many possible configurations for vent 306. For example, as shown in Figure 5a, vent 306 can be located directly beneath upper passage 302 and consist of a single cross-sectional opening formed in the inner curved surface of lower liner 284. The cross-sectional opening into chamber 222 is preferably at least as long as the diameter of the processing area on susceptor 220. In another embodiment, as shown in Figure 5b, vent 306 can consist of a plurality of discreet holes or passages 502 formed in the inner curved surface of lower liner 284 and which are each coupled to exhaust passage 300. The shape of vent 306 should be such that it provides little affect on the laminar flow of deposition gas 400 in the upper portion 222 of chamber 212.

The relative flow rates 402a and 402b through gap 229 and vent 306, respectively, are governed by the ratio of the cross-sectional area of gap 229 and the cross-sectional area of vent 306. In the preferred embodiment of the present invention as shown in Figure 4, where the preheat ring and susceptor are coplanar, the cross-sectional area of gap 229 is the area defined by the enclosed area of preheat ring 228 minus the area of susceptor 220 (i.e., $\pi R_p^2 - \pi R_s^2$). If susceptor 220 and preheat ring 228 are interleavened then the relevant cross-sectional area is the smallest surface area which exists between preheat ring 228 and susceptor 220. The cross-sectional area of vent 306 is defined as the total surface area of vent 306 which opens into lower chamber

portion 224. In the case of a plurality of discreet passages as shown in figure 5b, the relevant cross-section area is the sum of the areas of each opening 502.

According to the present invention, the cross-sectional area of vent 229 is maximized so as to exhaust as much of the purge gas flow as possible through vent 306. In this way a sufficient amount of heated inert purge gas is provided to prevent deposition gas from condensing in the exhaust passage. The cross-sectional area of vent 306 is dictated by two requirements. First, the cross-sectional area of vent 306 cannot be so large so as to affect the mechanical strength and integrity of lower liner 284. Additionally, the ratio of cross-sectional area of gap 229 and vent 306 must be balanced so that the inert purge gas flow 402a through gap 229 is sufficient to prevent the diffusion of deposition gases from the upper chamber portion 222 into the lower chamber portion 224. A gap 229 to vent 306 cross-sectional area ratio of approximately 3:1 has been found to provide good results for a deposition gas flow of between 45-70 slm and a purge gas flow of greater than 12 slm in a five liter chamber.

An apparatus and method for preventing condensation of deposition gas in an exhaust passage of a deposition apparatus has been described. It is to be appreciated and understood that the specific embodiments of the invention described herein are merely illustrative of the general principles of the invention. Various modifications may be made consistent with the principles set forth. For example, although the present invention has been described with respect to a single substrate reactor for depositing a silicon film on a semiconductor wafer, the present invention is equally applicable for use in other machinery such as multi-wafer chambers, and for other substrates, such as substrates for flat panel displays, and for other films such as metals.

As such, the scope of the present invention is to be measured by the appended claims which follow.

Thus, a novel method and apparatus for preventing the condensation an exhaust gas in an exhaust passage has been described.

4. Brief Description of Drawings

Figure 1 is an illustration of a cross-sectional view of a single wafer reactor.

Figure 2 is an illustration of a single wafer reactor of the present invention.

Figure 3 is an illustration of an expanded cross section view of the gas exhaust outlet of the single wafer reactor of the present invention.

Figure 4 is an illustration of an overhead view of the susceptor and preheat member of the single wafer reactor of the present invention.

Figure 5a is an illustration of a frontal view of the vent and exhaust passage of an embodiment of the present invention.

Figure 5b is an illustration of a frontal view of the vent and exhaust passage of another embodiment of the present invention.

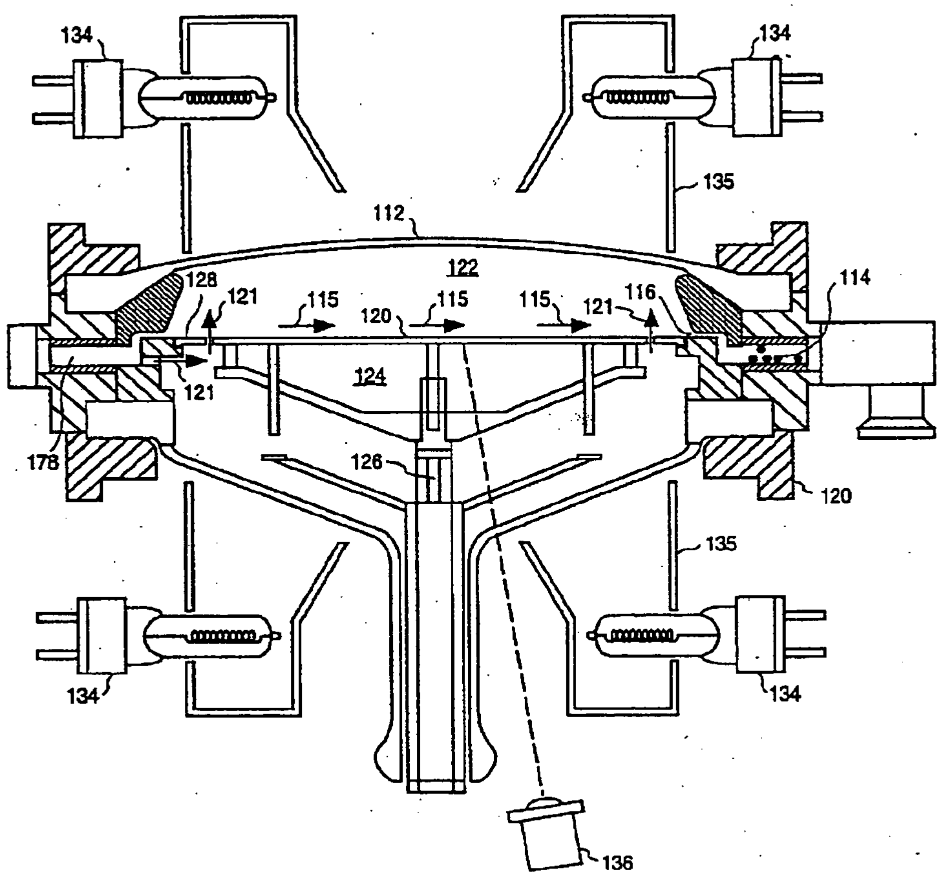

134
134
135
112
122
128
121
115
120
115
115
121
116
114
121
124
178
126
120
135
134
134
136

FIG. 1

P98AM－056 (2)

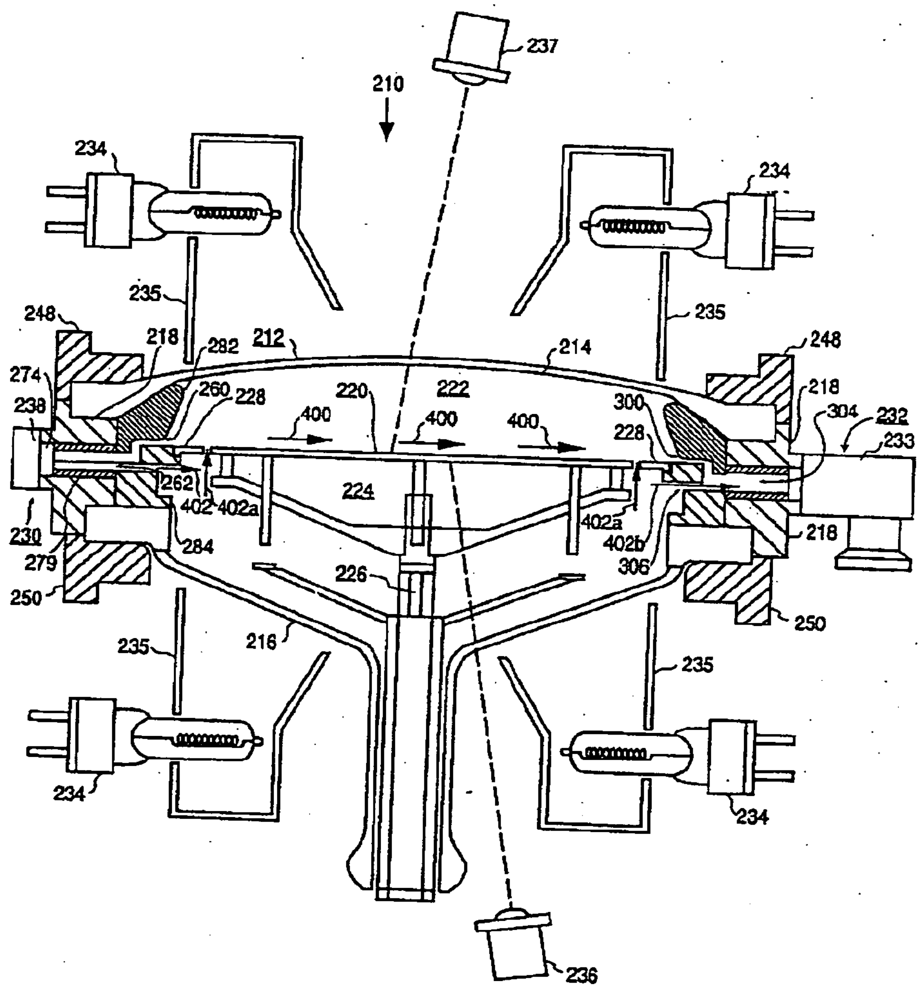


FIG. 2

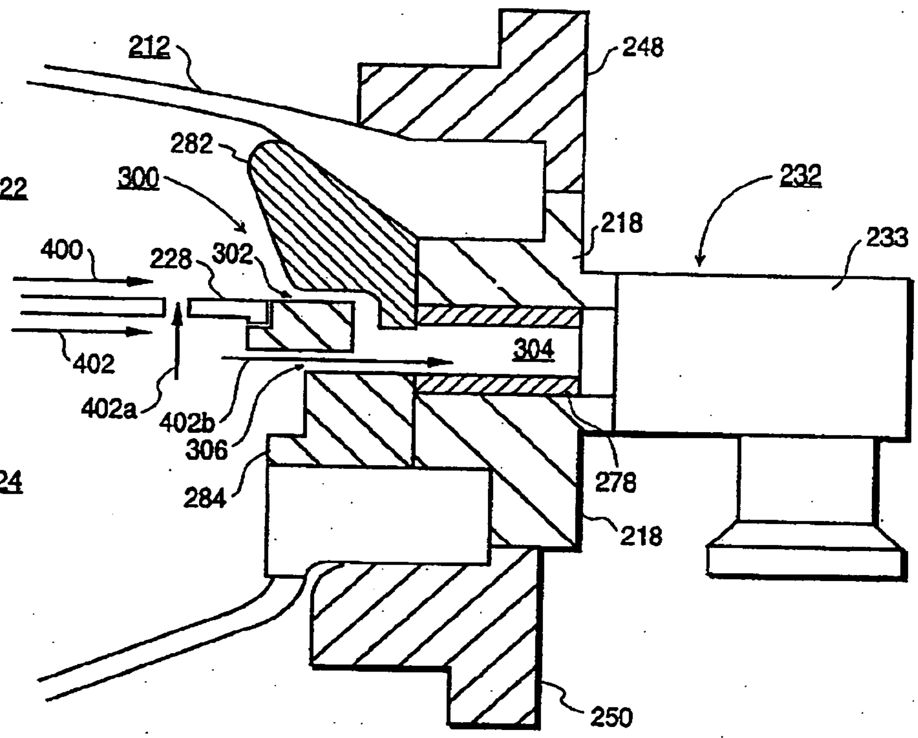

212
248
282
300
222
232
218
233
400
228
302
304
402
402a
402b
306
278
224
284
218
250

FIG. 3

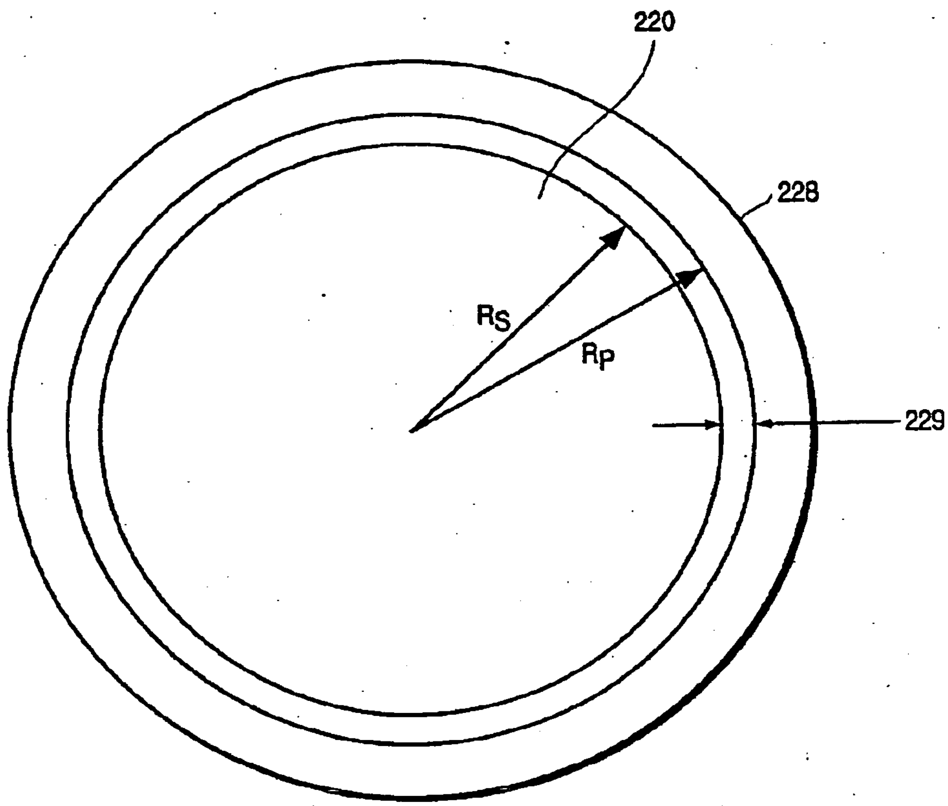


FIG. 4

P98AM-056 (5)

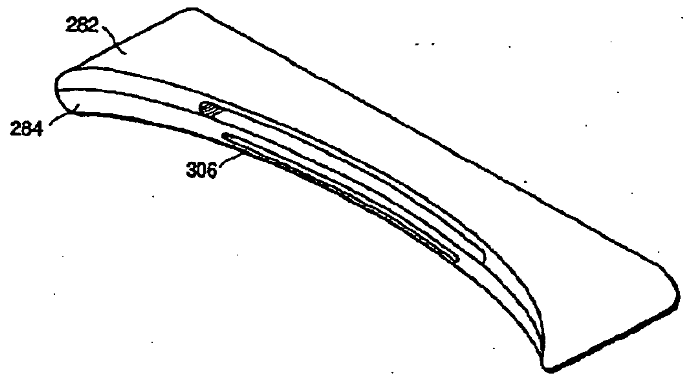


FIG. 5A

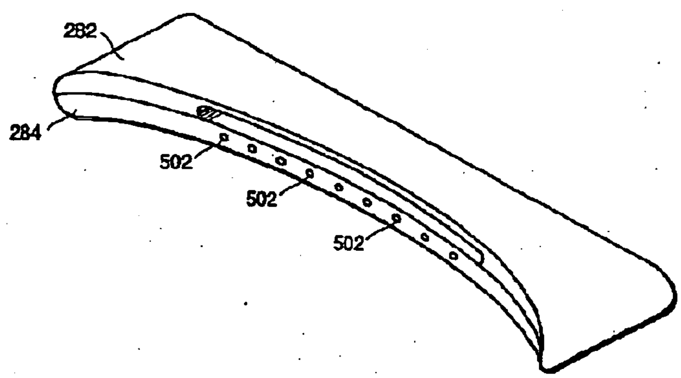


FIG. 5B

1. Abstract

ABSTRACT OF THE INVENTION

The present invention is a single wafer reactor having a vented lower liner for heating exhaust gas. The apparatus of the present invention includes a reaction chamber. A wafer support member which divides the chamber into an upper and lower portion is positioned within the chamber. A gas outlet for exhausting gas from the chamber has a vent to exhaust gas from the lower portion of the chamber and an exhaust passage opening to exhaust gas from the upper portion of the chamber. Heated inert purge gas is fed from the lower chamber portion through the vent at a rate so as to prevent the deposition gas from condensing in the exhaust passage.

2. Representative Drawing

Fig. 2

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号

特開平11－45861

(43)公開日　平成11年(1999) 2月16日

(51)Int.Cl.⁶	識別記号	ＦＩ	
Ｈ０１Ｌ　21/205		Ｈ０１Ｌ　21/205	
Ｃ２３Ｃ　16/44		Ｃ２３Ｃ　16/44	Ｄ

審査請求　未請求　請求項の数12　ＯＬ　外国語出願　（全 34 頁）

(21)出願番号　特願平10－137330

(22)出願日　平成10年(1998) 4月10日

(31)優先権主張番号　０８／８３５９５５

(32)優先日　1997年4月11日

(33)優先権主張国　米国（ＵＳ）

(71)出願人　390040660
アプライド　マテリアルズ　インコーポレイテッド
ＡＰＰＬＩＥＤ　ＭＡＴＥＲＩＡＬＳ，ＩＮＣＯＲＰＯＲＡＴＥＤ
アメリカ合衆国　カリフォルニア州 95054　サンタ　クララ　バウアーズ　アベニュー　3050

(72)発明者　ポール　ピー．　コミタ
アメリカ合衆国，　カリフォルニア州，メンロ　パーク，　ハーモサ　ウェイ 350

(74)代理人　弁理士　長谷川　芳樹　（外４名）

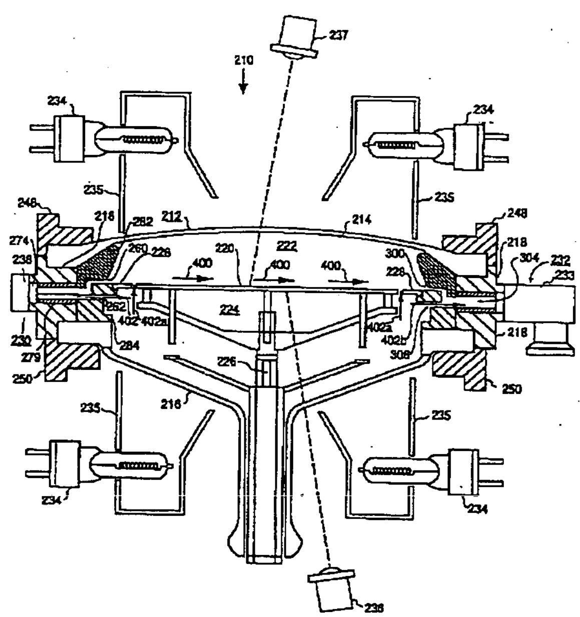
最終頁に続く

(54)【発明の名称】　枚葉式リアクタ内の、排ガスを加熱するための穴のあいた下方ライナ

(57)【要約】

【課題】　排気通路内の堆積物形成を低減し、チャンバ下部からの金属汚染を減らすことのできる方法及び装置を提供する。

【解決手段】本発明は、排ガスを加熱するための通気口を有する下部ライナを備えた枚葉式リアクタである。本発明の装置は反応チャンバを含む。チャンバを上部と下部に分割するウェーハ支持部材がチャンバ内部に配置されている。チャンバからガスを排出するためのガス出口は、チャンバ下部からガスを排出する通気穴と、チャンバ上部からガスを排出する排気通路開口部とを有する。加熱された不活性パージガスが、排気通路内における堆積ガスの凝縮を防止するように、チャンバ下部から通気穴を通して送られる。



【特許請求の範囲】
【請求項１】　半導体リアクタ内において、所定形状体を堆積する方法であって、
堆積ガスを反応チャンバ内に流し入れるステップと、
前記堆積ガスを排気通路を通して排出させるステップと、
前記排気通路内における前記堆積ガスの凝縮を防止するような流量で、加熱された不活性パージガスを前記排気通路内に流入するステップと、を備える方法。
【請求項２】　枚葉式リアクタ内でウェーハ上に膜を堆積する方法であって、
側壁を有する堆積チャンバをチャンバ上部及びチャンバ下部に分割しているサセプタに、ウェーハを配置するステップと、
堆積ガスを、前記チャンバ上部に流し入れ、前記ウェーハを横切らせ、前記チャンバ上部から前記側壁を通って延びた排気通路を通して流出させるステップと、
パージガスを、前記チャンバ下部に流し入れ、前記チャンバ下部から前記排気通路に延びた下方通路を通して流出させるステップと、
前記パージガスを、前記チャンバ内にある間に加熱するステップと、前記パージガスを、前記排気通路内における前記堆積ガスの凝縮を防止する流
量で前記下方通路を通して流すステップと、を備える方法。
【請求項３】　枚葉式リアクタ内のウェーハ上に膜を堆積するための方法において、
側壁を有する堆積チャンバ内部に配置されたサセプタ上にウェーハを配置するステップであって、前記サセプタが、前記堆積チャンバを前記ウェーハより上方の上部と前記ウェーハより下方の下部とに分割しているステップと、
前記堆積チャンバの前記上部に堆積ガスを流入するステップと、
前記堆積チャンバの前記上部から前記側壁を通って延びる排気通路を通して前記堆積ガスを排出するステップと、
前記堆積チャンバの前記下部内へとパージガスを流入させるステップであって、前記パージガス流が前記サセプタ板と前記サセプタ板を取り囲む予熱部材との間の隙間を通る前記堆積ガスの前記堆積チャンバの前記下部への流入を実質的に防止しているステップと、
前記チャンバ下部から前記排気通路に延びた下方通路を通して前記パージガスを排出するステップであって、前記加熱されたパージガスが前記排気通路内における前記堆積ガスの凝縮を防止しているステップと、を備える方法。
【請求項４】　ウェーハ上に材料層を堆積するための堆積装置であって、
側壁を有する堆積チャンバと、
前記堆積チャンバ内部の第１の平面上に設けられたサセプタ板であって、前記堆積チャンバを横断して延び、前記堆積チャンバをウェーハが支持されるサセプタ板上面より上方にある上部とサセプタ板の裏面より下方にある下部とに分割しているサセプタ板と、
前記第１の平面上で前記サセプタ板を取り囲む、第１の断面積を有する隙間によって前記サセプタ板と隔てられている予熱リングと、
前記堆積チャンバの前記下部から前記排気通路に延びた、第２の断面積を有する前記通気穴と、
前記堆積チャンバの前記上部から前記側壁を通って延びた排気通路と、を備え、
前記第２の断面積と前記第１の断面積とが、チャンバ下部内の加熱されたパージガスが前記隙間を通ってチャンバ上部内の堆積ガスが流れることを防止し且つ該パージガスが前記排気通路内に十分な量の加熱ガスを提供して前記排気通路中の堆積ガスが同通路内で凝縮しないような相対的関係になっている装置。
【請求項５】　前記通気穴が、前記排気通路開口部の真下に配置された１個の細長い開口部を備える請求項４に記載の装置。
【請求項６】　前記通気穴が、別個に設けられた複数の開口部を備える請求項に記載４に記載の装置。
【請求項７】　前記第１の断面積と前記第２の断面積が、約３：１の比率である請求項４に記載の装置。
【請求項８】　前記パージガスが、複数のランプによって加熱される請求項４に記載の装置。
【請求項９】　上部ドームと下部ドームとを更に備え、前記側壁が前記上部ドームと前記下部ドームとの間に設けられた請求項４に記載の装置。
【請求項１０】　チャンバの壁内に設けられたガス入口マニホルドを更に備え、前記ガス入口マニホルドが、前記堆積チャンバの前記下部内にガスを導く少なくともひとつの通路開口部と前記堆積チャンバの前記上部内にガスを導く少なくともひとつの通路開口部とを有する請求項４に記載の堆積装置。
【請求項１１】　チャンバの壁内に設けられたガス入口マニホルドを更に備え、前記ガス入口マニホルドが、前記堆積チャンバの前記下部内にガスを導く少なくともひとつの通路開口部と、前記堆積チャンバの前記上部内にガスを導く少なくともひとつの通路開口部とを有する請求項８に記載の堆積装置。
【請求項１２】　ウェーハ上に材料層を堆積するための堆積装置であって、
側壁を有する堆積チャンバと、
前記堆積チャンバ内部の第１の平面上に設けられたサセプタ板であって、前記堆積チャンバを横断して延び、前記堆積チャンバをウェーハが支持されるサセプタ板上面より上方にある上部と、サセプタ板の裏面より下方にある下部とに分割しているサセプタ板と、

前記第１の平面上で前記サセプタ板を取り囲み第１の断面積を有する隙間によって前記サセプタ板と隔てられている前記予熱リングと、
前記堆積チャンバの前記上部内で前記側壁の内面に接して設置された上部ライナと、
前記堆積チャンバの前記下部内で前記側壁の内面に接して設置された下部ライナと、
前記堆積チャンバの前記下部から前記下部ライナを通って前記排気通路まで延び、第２の断面積を有する前記通気穴と、
前記上部ライナと前記下部ライナとの間に位置し、前記堆積チャンバの前記上部から前記側壁を通って延びた排気通路と、を備え、
前記第２の断面積と前記第１の断面積とが、チャンバ下部内の加熱されたパージガスが前記隙間を通ってチャンバ上部内の堆積ガスが流れることを防止でき、また該パージガスが前記排気通路内に十分な量の加熱ガスを提供して前記排気通路中の堆積ガスが同通路内で凝縮しないようにする相対的関係になっている装置。

【発明の詳細な説明】

【０００１】

【発明の背景】

１)発明の分野

本発明は半導体処理設備に関し、より詳細には、半導体処理装置内の粒子汚染を低減するための方法及び装置に関する。

【０００２】２)関連技術の検討

半導体ウェーハ処理装置の一形式に、処理チャンバ内で一回につき一枚のウェーハを処理する枚葉式プロセッサがある。枚葉式リアクタの例を図１に示す。サセプタ１２０が、チャンバ１１２を、サセプタより下方の一部分(下部)１２４と、サセプタより上部の第２の部分(上部)１２２とに分割している。サセプタ１２０は、一般に、中心を軸としてサセプタを回転させて、より均一なウェーハ処理を達成するシャフト１２６に取り付けられている。堆積ガス１１５等の処理ガス流は、チャンバ上部１２２に供給される。一般に、チャンバは、その一方の側面にガス入口通路１７８を有し、また反対側の側面に排気通路１１６を有し、ウェーハを横切る処理ガス流を達成している。サセプタ１２０は、ウェーハを所望の処理温度まで加熱するために加熱される。サセプタを加熱するために用いられる方法のひとつに、チャンバ周囲に備えられたランプ１３４を使用して、それらの光をチャンバ内及びサセプタ１２０上に向ける方法がある。ウェーハの加熱温度を制御するために、常時サセプタの温度は測定される。これは多くの場合加熱されたサセプタから放射される赤外線を検知する赤外線温度センサ１３６によって達成される。

【０００３】この種の処理装置の問題点は、一部の処理ガス（これは多くの場合ウェーハ表面に材料層を堆積させるための単一ガス又は混合ガスである）が、サセプタの縁部周辺に流れて、サセプタの裏面に材料層を堆積する傾向があることである。一般に堆積される材料はサセプタの材料とは異なっているため、堆積層は、サセプタの放射率とは異なる放射率を有している。従って、材料層がサセプタ裏面に堆積すると、赤外線温度センサは、赤外線が放射される表面の放射率変動に起因する変動を検知してしまう。この変動は、実際には存在しないサセプタの温度変動を示す。

【０００４】サセプタ裏面への堆積の問題を防止するために用いられてきた技法のひとつに、水素等の不活性ガス１２１の流れを、チャンバ上部内の堆積ガスの圧力より僅かに高い圧力でチャンバ下部に供給するものがある。これを達成するための装置のひとつは、１９９３年７月３０日に出願された、Roger N. Anderson他による米国特許出願第０８／０９９／９７７号明細書、発明の名称「ウェーハ処理チャンバのためのガス入口」に述べられている。チャンバ下部内の不活性ガスの方が高圧であるため、不活性ガスは、チャンバ下部からサセプタ縁部を回り込みチャンバ上部へと流れる。不活性ガスのこの流れが、チャンバ下部への堆積ガス１１５の流れを防止する。しかし残念なことに、パージガスがチャンバ１２２の上部１２２に配置する排気通路１１６を介して流出するために、チャンバ下部からチャンバ上部へと流れる際に、パージガスが金属汚染物質をチャンバ下部からチャンバ上部に運び、処理されるウェーハを汚染する結果となる。

【０００５】図１の処理装置に関連するもうひとつの問題点は、堆積ガス１１５が、排気通路１１６を介してチャンバから退出する際に堆積ガスが冷却され、凝縮され、排気通路１１６内部に堆積物１１４を形成することにある。堆積ガスが冷却されるのは図１の装置が「冷壁リアクタ(cold wall reactor)」だからである。すなわち、リフレクタ１３５のために側壁がランプ１３４によって直接照射されず、また側壁中を冷却流体が循環しているために処理中の堆積チャンバの側壁がサセプタ１２０(及びウェーハ)の温度よりも実質的に低いからである。側壁及び排気出口通路が低温であるために、サセプタ１２０によって加熱された堆積ガスは通路内にある間に冷えて、内部に堆積物１１４が形成される。これらの堆積物１１４はチャンバ１１２内に戻り、処理中のウェーハ上に載ってしまう恐れがある。堆積物１１４は、膜の品質と均一性に悪影響を及ぼし、デバイスの歩留まりを実質的に低下させ得る。

【０００６】従って、排気通路内の堆積物形成を低減し、チャンバ下部からの金属汚染を減らすことのできる方法及び装置が望まれる。

【０００７】

【発明の概要】本発明は、排ガスを加熱するための通気穴を有する（vented、穴のあいた）下部ライナを有する

枚葉式リアクタである。本発明の装置は、反応チャンバを含む。チャンバを上部と下部に分割するウェーハ支持部材が、チャンバ内部に配置されている。排気チャネルが、反応チャンバの側壁内に形成されており、チャンバ内部からガスが排出される。堆積ガスは、チャンバ上部と堆積チャンバ外面側壁との間に配置された排気通路を通して排出される。大流量の加熱されたパージガスは、チャンバ下部と排気通路との間に配置された通気穴を通してチャンバ下部より排出される。排気通路への大流量の加熱パージガスによって、排出される堆積ガスの排気通路内での凝縮並びに同通路内での堆積物形成が防止される。

【０００８】

【実施の形態の詳細な説明】本発明では、枚葉式処理リアクタの排気通路内における堆積ガスの凝縮を防止するための方法及び装置について述べる。以下の説明では、特定な加熱エレメントやガス等の数多くの特定な詳細を、発明の完全な理解を提供するために示す。他の事例、例えば公知のリアクタ寸法形状及びプロセスについては、本発明を不必要に分かりにくくしないために詳しい説明はしていない。

【０００９】本発明は枚葉式リアクタである。処理対象のウェーハを支持するサセプタが、堆積チャンバ内部に配置されて、チャンバを上部と下部に分割している。チャンバ上部に送られてウェーハを横切る堆積ガスは、チャンバ上部から堆積チャンバ内側壁を通って外部に延びた排気通路を通して排出される。H_2等の不活性ガスがチャンバ下部に送られて、チャンバ下部と排気通路との間に形成された通気穴から排出される。大流量の不活性パージガスによって、大量の加熱ガスを排気通路内部に提供されて、同通路内における堆積ガスの凝縮及び堆積物の形成が防止される。加えて、パージガスがチャンバ下部から直接排出されて、チャンバ下部からの金属汚染物質が低減される。

【００１０】本発明による半導体ウェーハ処理装置２１０を図２に示す。図示の処理装置２１０は堆積リアクタであって、上部ドーム２１４と、下部ドーム２１６と、上部ドーム２１４と下部ドーム２１６との間の側壁２１８とを有する堆積チャンバ２１２を備えている。ドーム２１４及び２１６を側壁２１８に取付けるために用いる複数の“Ｏ”リングを冷却する目的で、冷却流体（図示せず）が側壁２１８の中を循環している。上部ライナ２８２及び下部ライナ２８４が、側壁２１８の内部表面に接して取り付けられている。上部ドーム２１４及び下部ドーム２１６は、透過性素材から形成されており、加熱光がチャンバ２１２内部に通過できるようになっている。

【００１１】チャンバ２１２内部には、ウェーハを支持するための平坦で円形のサセプタ２２０がある。このサセプタ２２０は、側壁２１８にチャンバ２１２全体を横切って延びており、チャンバ２１２をサセプタ２２０より上の上部２２２と、サセプタ２２０より下の下部２２４とに分割している。サセプタ２２０は、サセプタ２２０の底部中央から垂直下方に延びたシャフト２２６上に取り付けられている。シャフト２２６は、シャフト２２６を回転させてサセプタ２２０を回転させるモータ（図示せず）と連結されている。環状の予熱リング２２８が、外側周縁部で下部ライナ２８４の内側周縁部と連結しており、サセプタ２２０を取り囲んで延びている。予熱リング２２８はサセプタ２２８と同平面にあって、予熱リング２２８の内縁は隙間２２９によってサセプタ２２０の外縁から離間されている。入口マニホルド２３０が、チャンバ２１２の側面に配置されており、ガスをチャンバ２１２内に導入するように適合されている。出口ポートが、入口マニホルドから対角に対向するチャンバ２１２の側面上に配置されており、堆積チャンバ２１２からガスを排出できるように適合されている。

【００１２】複数の高輝度ランプ２３４がチャンバ２１２の周りに装着されており、それらの光を上部ドーム２１４及び下部ドーム２１６を通してサセプタ２２０上に向け、サセプタ２２０を加熱する。上部ドーム２１４及び下部ドーム２１６は、ランプ２３４からの光に対して透過性のある透明な石英等の材料から形成されている。上部ドーム２１４及び下部ドーム２１６は、一般に石英から形成されているが、その理由は、石英が可視光線と赤外線周波数の両方の光に対して透過性である点、比較的高い構造強度を示す点、そして堆積チャンバ２１２の処理環境においても化学的に安定している点にある。ランプは、堆積チャンバ２２０内のウェーハを加熱するための望ましい手段ではあるが、抵抗加熱器やＲＦ誘導加熱器等の他の手段を用いても良い。高温計等の赤外線温度センサ２３６は、下部ドーム２１６より下に装着されており、下部ドーム２１６を通してサセプタ２２０表面の底部と向かい合っている。温度センサ２３６が、サセプタ２２０が加熱される際にサセプタ２２０から放射される赤外線を受けてサセプタ２２０の温度をモニタするために用いられる。任意で、ウェーハの温度を測定するための温度センサ２３７を同時に組み込んでも良い。

【００１３】上部クランプリング２４８が、上部ドーム２１４の外面周縁部を囲んで延びている。下部クランプリング２５０は、下部ドーム２１６の外面周縁部を囲んで延びている。上部及び下部クランプリングは共締めされていて、上部ドーム２１４及び下部ドーム２１６は側壁２１８に締め付けられている。

【００１４】リアクタ２１０は、堆積チャンバ２１２の中に堆積ガスを送るための堆積ガス入口マニホルド２３０を含む。ガス入口マニホルド２３０は、バッフル２７４、側壁２１８内部に配置された挿入プレート２７９、及び上部ライナ２８２と下部ライナ２８４との間に形成された通路２６０を含む。通路２６０はチャンバ２１２

の上部２２２と繋いでいる。シリコンソースガス、ドーパントソースガス、及びキャリヤガス等の堆積ガスは、ガスキャップ２３８からバッフル２７４、挿入プレート２７９、及び通路２６０を介して、チャンバ２１２の上部２２２に送られる。

【００１５】リアクタ２１０はまた、水素(H_2)又は窒素(N_2)等（これらに限定されないが）の不活性パージガスを、堆積チャンバ２１２の下部２２４に送るための独立した不活性ガス入口２６２を含む。図２に示すように、不活性パージガス入口２６２は、所望であれば、バッフル２７４、挿入プレート２７９及び下部ライナ２８４を通り抜ける物理的に分離された個別の通路２６２が不活性ガスのために備えられている限り、ガス入口マニホルド２３０と一体化することもでき、その結果、不活性パージガスは、堆積ガスとは関係なく制御及び方向付けができる。不活性パージガス入口２６２は、必ずしも堆積ガス入口マニホルド２３０と一体化又はそれに沿って配置する必要はなく、例えば堆積ガス入口マニホルド２３０に対して９０°の角度を有するようにリアクタ２１０上に配置しても良い。

【００１６】本発明における枚葉式リアクタのガス出口２３２の実施形態の側方断面図を図３に示す。ガス出口２３２は、チャンバ上部２２２から側壁２１８の外径まで延びた排気通路３００を含む。排気通路３００は、上部ライナ２８２と下部ライナ２８４との間に形成され、チャンバ上部２２２と側壁２１８の内径との間に延びた上部通路３０２を含む。加えて、排気通路３００は、側壁２１８内部に配置された挿入プレート２７８の内部に形成された排気チャネル３０４も含む。堆積チャンバ２１２内に低圧あるいは減圧状態を作り出すための、ポンプ(図示せず)等の負圧ソースが、出口パイプ２３３を介して側壁２１８の外側で排気チャネル３０４に連結されている。従ってチャンバ上部２２２に送り込まれた堆積ガスは、上部通路３０２から排気チャネル３０４を通って、出口パイプ２３３へと排出される。

【００１７】図２に示す枚葉式リアクタは、「冷壁」リアクタである。すなわち、側壁２１８並びに上部ライナ２８２及び下部ライナ２８４は、各々処理中はサセプタ２２０(及びその上に置かれているウェーハ)よりも実質的に低い温度である。例えば、ウェーハ上にエピタキシャルシリコン膜を堆積させるプロセスでは、サセプタ及びウェーハは９００～１２００℃の間の温度まで加熱され、一方、側壁(及びライナ)は約４００～６００℃の温度である。側壁及び各ライナの温度が低いのは、リフレクタ２３５があってランプ２３４からの直接照射を受けないためと、側壁２１８を通って冷却流体が循環しているためとによる。

【００１８】ガス出口２３２はまた、チャンバ下部２２４から下部ライナ２８４を通して排気通路３００まで延びた通気穴３０６も含んでいる。通気穴３０６は、図３に示すように排気通路３００の上部通路３０２と交差しているのが望ましい。不活性パージガスは、チャンバ下部２２４から通気穴３０６を通り、上部チャンバ通路３０２の一部を抜け、排気チャネル３０４を通り、出口パイプ２３２へと排出される。通気穴３０６はチャンバ下部から排気通路３００へパージガスが直接排出されることができるようにしている。

【００１９】本発明によれば、堆積ガスあるいは各種ガス４００が、ガス入口マニホルド２３０からチャンバ上部２２２に送られる。本発明で堆積ガスとは、チャンバ２１２内に配置されるウェーハあるいは基板上に膜を堆積するように作用するガスあるいは混合ガスと定義する。本発明の好ましい方法で堆積ガスは、サセプタ２２０の上に配置されたウェーハ上にシリコンのエピタキシャル層を堆積させるために用いる。堆積ガス４００は一般に、モノシラン、トリクロラルシラン（trichloralsilane）、ジクロラルシラン（dichloralsilane）、及びテトラクロロルシラン（tetrachlorolsilane）等（これらに限定されないが）のシリコンソース、並びにホスフェン（phosphene）、ジボラン、及びアルシン等（これらに限定されない）のドーパントガスソースを含んでいる。H_2等のキャリヤガスが、一般に堆積ガス流に含まれている。約５リットルの堆積チャンバに対して、３５～７５ＳＬＭの堆積ガス流(キャリヤガスを含む）が、通常チャンバ上部２２２に送られて、ウェーハ上にシリコン層が堆積される。堆積ガス４００の流れは、本質的に入口通路２６０から予熱リング２２８を横切り、サセプタ２２０(及びウェーハ)を横切り、反対側の予熱リング２２８を横切り、排気通路３００から外に出る層流である。堆積ガスは、予熱リング２２８、サセプタ２２０、及び処理されるウェーハによって堆積温度あるいはプロセス温度まで加熱される。エピタキシャルシリコン層をウェーハ上に堆積するプロセスでは、サセプタ及び予熱リングは８００～１２００℃の間の温度まで加熱される。

【００２０】更に、堆積ガスがチャンバ上部へと送られる一方で、単数あるいは複数の不活性ガスが、別個にチャンバ下部２２４へと送られる。不活性パージガスとは、プロセス温度においてチャンバのフィーチャ（feature）と、堆積チャンバ２１２内部に配置されたウェーハとに対して実質的に反応を起こさないガスと定義する。この不活性パージガスは、チャンバ２１２内にある間、予熱リング２２８及びサセプタ２２０によって基本的に堆積ガスと同じ温度に加熱される。不活性パージガス４０２は、チャンバ上部２２２における堆積ガスの圧力に対して正の圧力をチャンバ下部２２４内部に発生させるような流量でチャンバ下部２２４へと送られる。従って、膜堆積ガス４００が隙間２２９を通ってチャンバ下部２２４へと漏れ、サセプタ２２０の裏側に堆積するのを防止できる。

【0021】更に、不活性パージガス402は、通気穴306を通る排気通路300への十分な不活性パージガス流402ｂを提供できる流量でチャンバ下部224内に送られ、堆積ガスが排気通路300の排気チャネル304内で凝縮してその中に堆積物が形成されないようにしている。すなわち、十分な量の加熱されたパージガスが排気チャネル304に送られて、排気チャネル304が加熱され、それによって排気チャネル304内における堆積ガス400の冷却及びその結果生じる同チャネル内の堆積物形成が防止される。排気チャネル304への大流量の加熱パージガス402ｂがないと、排気チャネル304は、側壁218が水冷されているために、サセプタ220よりも実質的に冷えた状態になり、同チャネル内に堆積物が形成される点を正しく認識すべきである。従って本発明によれば、望ましくは2～24ＳＬＭである大流量不活性パージガス402ｂによって堆積ガスが隙間229を通って下方に漏れることが防止されて、また堆積ガスは排気チャネル304内での凝縮を防止する目的でチャンバ212の下部224へと送られる。

【0022】図5（ａ）及び図5（ｂ）は、考えられる多くの通気穴306形状のうち2つの形状の正面断面図を示している。図5（ａ）に示す通り、例えば、通気穴306は、上部通路302の真下に配置されて、下部ライナ284の湾曲した内部表面に形成された単一の断面を有する開口部として構成されることができる。チャンバ222に繋がった横断面上の開口部は、少なくともサセプタ220の処理域直径と同じ長さを有しているのが望ましい。図5（ｂ）に示すような他の実施形態では、通気穴306は、下部ライナ284の湾曲した内部表面に形成されて、それぞれが排気通路300と結合した複数の分離された孔又は通路502として構成されることもできる。通気穴306の形状は、チャンバ212の上部222内の堆積ガス400の層流にほとんど悪影響を及ぼさない形状とすべきである。

【0023】隙間229と通気穴306を通過する相対的流量402ａ及び402ｂはそれぞれ、隙間229の断面積と通気穴306の断面積との比率によって決定される。図4に示す本発明の好ましい実施形態では、予熱リングとサセプタが同一平面上にある場合、隙間229の断面積は、予熱リング228で囲まれた面積からサセプタ220の面積を差し引いたものとなる（すなわち$\pi R_p{}^2-\pi R_s{}^2$）。サセプタ220と予熱リングが間にある場合、該当断面積は、予熱リング228とサセプタ220との間に存在する最小の面積ということになる。通気穴306の断面積は、チャンバ下部224内に開放した通気穴306の表面積の合計で画される。図5（ｂ）に示した複数の分離した通路の場合、該当断面積は、各開口部502の面積を合計したものとなる。

【0024】本発明によれば、通気穴229の表面積はできるだけ大量のパージガス流を通気穴306から排出するように最大化されている。この方法で十分な量の加熱された不活性パージガスが提供されて、排気通路内での堆積ガスの凝縮が防止される。通気穴306の断面積は、2つの要件によって決定付けられる。先ず、通気穴306の断面積は、下部ライナ284の機械的強度及び保全性に悪影響を及ぼすほど大きくできない。加えて、隙間229と通気穴306の断面積比率がバランス良く配分されて、その結果、隙間229を通る不活性パージガス流402ａが、チャンバ上部222からチャンバ下部224への堆積ガス拡散を防止できるだけの十分な量とならなければならない。隙間229の断面積と通気穴306の断面積との比率を約3：1にすると、5リットルのチャンバで堆積ガス流量が45～70ｓｌｍ、パージガス流量が12ｓｌｍを超える、良好な結果が得られることが見出された。

【0025】堆積装置の排気通路内における堆積ガスの凝縮を防止するための装置及び方法について述べた。本明細書で述べた本発明の特定実施形態は、単に本発明の一般的な原理を例証しているにすぎないことを認識し、理解すべきである。前記原理に沿った様々な変更を施すことができる。例えば、本発明を半導体ウェーハにシリコン膜を堆積するための枚葉式リアクタに関して説明してきたが、本発明は、マルチウェーハチャンバ等の他の機械装置用、またフラットパネルディスプレイの基板等の他の基板用、そして金属等の他種の膜用としても全く同様に適用することができる。

【0026】そのような、本発明の範囲は、請求項によって判断される。

【0027】以上、排気通路内における排ガスの凝縮を防止する新規な方法及び装置について説明した。

【図面の簡単な説明】

【図1】枚葉式リアクタの断面図である。

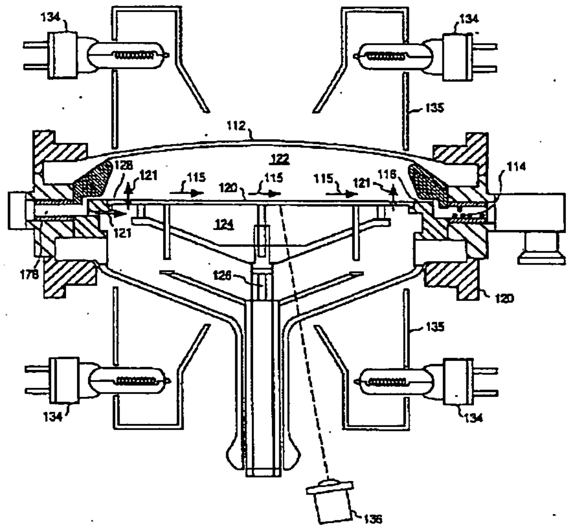
【図2】本発明の枚葉式リアクタである。

【図3】本発明の枚葉式リアクタにおけるガス排出口の拡大断面図である。

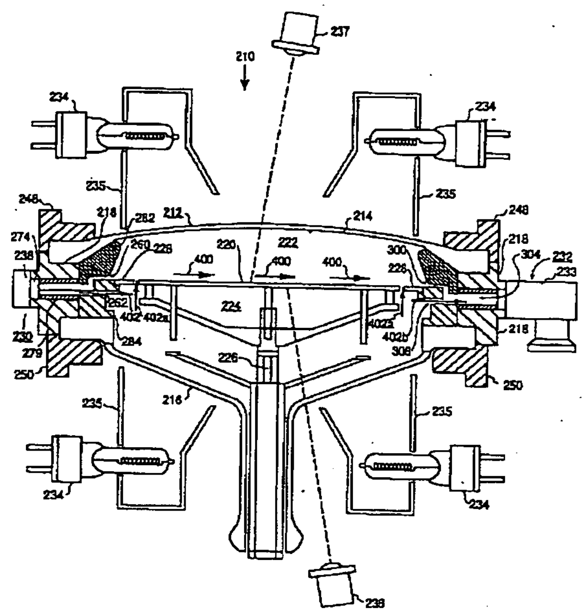
【図4】本発明の枚葉式リアクタにおける予熱部材及びサセプタの平面図である。

【図5】（ａ）は、本発明の実施形態における通気穴及び排気通路の正面図であり、（ｂ）は、本発明の別の実施形態における通気穴及び排気通路の正面図である。

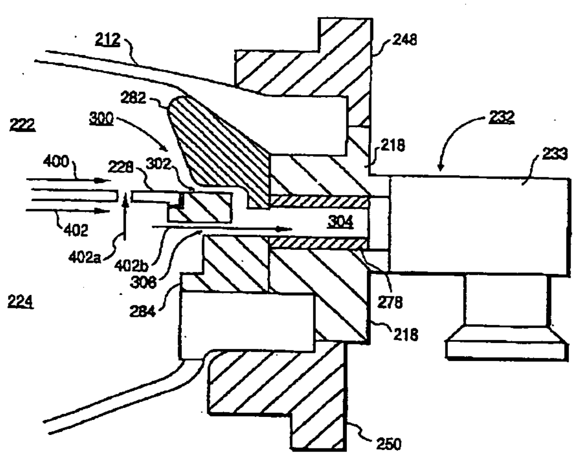
【図１】


134
135
112
122
128
121
115
120
116
114
124
126
178
136

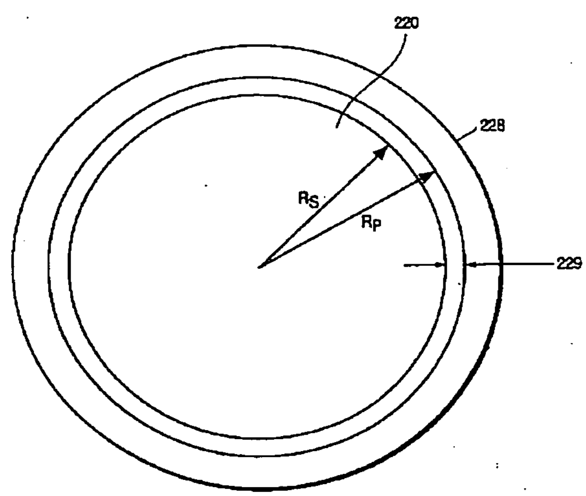
【図２】


237
210
234
235
212
214
248
218
282
260
220
222
300
226
274
238
304
232
233
400
262
402
402a
224
402b
230
279
284
306
250
216
236

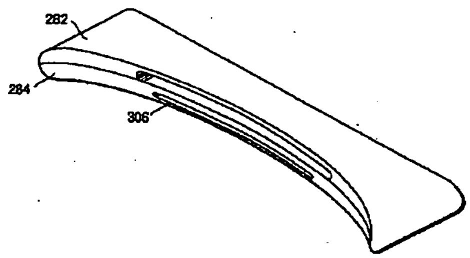
【図３】


212
248
282
300
232
222
218
233
400
228
302
304
402
402a
402b
306
224
284
278
250

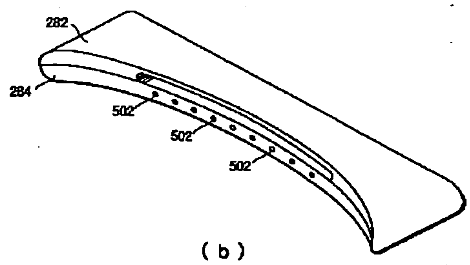
【図４】


220
228
Rs
Rp
229

【図5】



(a)



(b)

フロントページの続き

(72)発明者　デイヴィッド　ケー．　カールソン
アメリカ合衆国，　カリフォルニア州，
サンタ　クララ，　ダンディー　ドライヴ
2308

(72)発明者　ノーマ　ビー．　ライリー
アメリカ合衆国，　カリフォルニア州，
フルザントン，　ウェスト　ラス　ポシタ
ス　3710

(72)発明者　ドリア　ダブリュー．　ファン
アメリカ合衆国，　カリフォルニア州，
サン　フランシスコ，　アルビオン　スト
リート　152

(72)発明者　レクハ　ランガナサン
アメリカ合衆国，　カリフォルニア州，
サニーヴェイル，　ロキンバー　アヴェニ
ュー　1180，　ナンバー125